APTD-0826

PB 207 695

OMAHA METROPOLITAN AREA AIR POLLUTANT EMISSION INVENTORY

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
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BIBLIOGRAPHIC DATA SHEET	1. Report No. APTD-0826	2.	3. Recipient's Accession No.
4. Title and Subtitle Omaha Metropolitan Area Air Pollutant Emission Inventory			5. Report Date February 1970 6.
7. Author(s) Alan J. Hoffman			8. Performing Organization Rept. No.
9. Performing Organization Name and Address U. S. Department of Health, Education, and Welfare National Air Pollution Control Administration Division of Air Quality and Emission Data Durham, North Carolina			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address Same			13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstracts

A summary report is presented of the emission inventory for the Omaha Council Bluffs Metropolitan Area. The report provides estimates of the present levels of air pollutant emissions and status of their control. The pollutants which include sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides are delineated with respect to source type, season of the year, and geographical distribution within the area. The Study Area, which was chosen on the basis of the distribution of population and air pollution sources, consists of six counties surrounding the city of Omaha in Nebraska and two counties in Iowa. A grid coordinate system was used to show the geographical distribution of emissions within counties. All sources of emissions were classified into five categories: transportation, stationary fuel combustion, solid-waste disposal, industrial processes, and evaporative losses.

17. Key Words and Document Analysis. 17a. Descriptors

Air pollution
Emission
Inventories
Sulfur oxides
Nitrogen oxides
Hydrocarbons
Carbon monoxide
Particles
Seasonal variation
Sources
Fuel
Combustion
Transportation
Waste disposal
Industrial plants
Evaporation

17b. Identifiers/Open-Ended Terms

Particulates
Omaha, Nebraska
Nebraska
Iowa

17c. COSATI Field/Group 13B

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited	UNCLASSIFIED	64
	20. Security Class (This Page) UNCLASSIFIED	22. Price

OMAHA METROPOLITAN AREA
AIR POLLUTANT EMISSION INVENTORY

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
National Air Pollution Control Administration
Durham, North Carolina
February 1970

ACKNOWLEDGMENTS

Sincere gratitude is extended by the National Air Pollution Control Administration to the many individuals and companies who contributed to this air pollution emission inventory.

Special thanks are extended to Donald Olson of the the Omaha-Douglas County Health Department and C.L. Campbell of the Iowa State Department of Health, who contributed invaluable assistance in the gathering of data for this report.

PREFACE

This report, which presents the emission inventory for the Omaha-Council Bluffs Metropolitan Area, is another in a series of surveys outlining the sources and emissions of air pollutants for major metropolitan areas in the country. These surveys, conducted by the National Inventory of Air Pollutant Emissions and Control Branch of the National Air Pollution Control Administration, provide estimates of the present levels of air pollutant emissions and status of their control. The pollutants, which include sulfur oxides, particulates, carbon monoxide, hydrocarbons and nitrogen oxides, are delineated with respect to source type, season of the year and geographical distribution within the area. The general procedure for the surveys is based upon the rapid survey technique for estimating air pollutant emissions.[1] These reports are intended to serve as aids in the proposing of boundaries of Air Quality Control Regions, as directed by the Air Quality Act of 1967.

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INTRODUCTION

This report is a summary of the Omaha-Council Bluffs area air pollutant emission inventory conducted in October, 1969. Since all inventories are based upon a calendar year, the data and emission estimates presented are representative of 1968 and should be considered as indicating the conditions as existed during that year.

The Study Area, which was chosen on the basis of the distribution of population and air pollution sources, consists of six counties surrounding the city of Omaha in Nebraska and two counties in Iowa. This area covers approximately 4,210 square miles and had a 1968 population of 625,000.

A grid coordinate system was used to show the geographical distribution of emissions within counties. The Study Area was subdivided into 52 grid zones ranging in size from 25 square kilometers in the heavily populated and industrialized areas to 400 square kilometers in the rural areas.

All sources of emissions were classified into five categories--transportation, stationary fuel combustion, solid-waste disposal, industrial processes and evaporative losses. Each of these source categories was divided into two subgroups--point sources and area sources. Facilities, which emit large quantities of air pollutants, were considered individually as point sources, while the many remaining contributors such as motor vehicles, residential fuel users, small commercial and industrial facilities and on-site refuse burning equipment, were considered collectively as area sources. For this report, 28 individual sources, which had emissions greater than 0.5 tons per average annual day for any pollutant, were classified as point sources.

Emissions were estimated by using various indicators such as fuel consumption, refuse burning rates, vehicle-miles, production data, and control efficiencies and emission factors relating these indicators to emission rates.[2] These factors represent average emission rates for a particular source category. Since individual sources have inherent differences that cannot always be taken into consideration, discrepancies between the actual and estimated emissions are more likely in individual sources than in the total emissions for a source category.

As in all emission surveys, the data presented are estimates and should not be interpreted as absolute values. The estimates are, in some cases, partial totals due to the lack of emission factors and production or consumption data. Despite these limitations, the estimates are of sufficient accuracy and validity in defining the extent and distribution of air pollutant emissions within the Study Area.

SUMMARY OF RESULTS

The estimated annual emissions of the five surveyed pollutants in the Omaha-Council Bluffs Metropolitan Area are presented in Table 1. The following is a brief summary of pollutant emissions and sources.

Sulfur Oxides — The predominant sources of the 57,300 tons of sulfur oxides emitted annually are the combustion of fuels (64 percent) and industrial process losses (32 percent)

Particulate Matter — The annual emissions of 31,030 tons are distributed between the various source types. The largest source is industrial processes with transportation being the second largest.

Carbon Monoxide — Motor vehicles contribute 89 percent of 298,000 tons of carbon monoxide emitted within the Study Area in 1968. Other important sources include solid waste disposal and industrial processes.

Hydrocarbons — The two largest sources of the yearly 54,000 tons of hydrocarbons are motor vehicles and evaporative losses. They contribute 41 and 39 percent respectively.

Oxides of Nitrogen — Motor vehicles and stationary fuel combustion are the important sources of the 39,300 tons of oxides of nitrogen. The four steam-electric utilities alone account for 27 percent of the total emitted.

TABLE 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN THE OMAHA-COUNCIL BLUFFS STUDY AREA, 1968 (TONS/YEAR)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation	2,330	5,280	273,600	25,850	21,500
Motor Vehicles	1,590	3,030	266,000	22,100	17,000
Aircraft	N	240	6,500	1,260	440
Vessels	30	70	40	90	140
Railroads	710	1,940	1,060	2,400	3,920
Stationary Fuel Combustion	36,570	2,120	180	130	15,270
Industrial	700	270	10	10	2,600
Steam-Electric	35,100	1,350	120	50	10,500
Residential	770	410	50	70	1,640
Commercial-Institutional	N	90	N	N	530
Solid Waste Disposal	400	4,530	21,710	6,220	2,520
Incineration	190	930	4,110	70	280
Open Burning	210	3,600	17,600	6,150	2,240
Industrial Processes	18,000	19,100	2,500	0	0
Evaporative Losses				21,500	
TOTAL	57,300	31,030	298,000	53,700	39,300

N = Negligible

STUDY AREA

The Study Area for the Omaha-Council Bluffs Metropolitan Area Air Pollutant Emission Inventory consists of six counties in east central Nebraska and two counties in Iowa. The Nebraska Portion of the Study Area contains 35 percent of the State's population. Figure 1 presents the Study Area in relation to other large metropolitan areas.

The eight counties consist of Cass, Dodge, Douglas (Omaha), Sarpy, Saunders and Washington in Nebraska and Pottawattamie (Council Bluffs) and Mills in Iowa. (Figure 2) Three of the counties are in a designated Standard Metropolitan Statistical Area (SMSA) as defined by the Bureau of the Budget. This SMSA contains Douglas, Sarpy and Pottawattamie Counties. The other counties were added in the study to insure that all counties which may have a high rate of growth in future years were included.

The approximate 1968 population for the Study Area was 625,000 which covers an area of 4210 square miles. Table 2, which gives population by county and Figure 3, which shows the population density, indicate that most of the population is in the urbanized portions of Douglas and Pottawattamie Counties. The population in this area has increased at a quicker pace than the nation as a whole. Between 1960 and 1968, the nation's population increased over 11 percent while the Omaha-Council Bluffs Study Area increased 13.3 percent.

The climate is typically continental with relatively warm summers and dry, cold winters. Since the Study Area is situated between two distinctive climatic zones, weather conditions occur which are characteristic of either zone or combinations of both (i.e., the humid east and dry west). Omaha is also affected by most storms that cross the country. The prevailing wind during the winter is from the north-northwest averaging about 13 MPH. During the summer the SSE wind direction predominates with an average speed of 10 MPH.

TABLE 2 POPULATION AND AREA CHARACTERISTICS FOR THE STUDY AREA, 1968

County	Population 1960	Population 1968	Area sq. miles	Population Density
Cass	17,821	17,010	557	30.5
Dodge	32,471	36,500	528	69.1
Douglas	343,490	395,750	335	1,181.3
Sarpy	31,281	47,250	239	197.6
Saunders	17,270	15,780	759	20.8
Washington	12,103	12,980	386	33.6
Pottawattamie	83,102	86,900	963	90.2
Mills	13,050	12,440	447	27.8
TOTAL	550,588	624,610	4,214	148.2

Figure 1. Omaha-Council Bluffs study area and surrounding cities.

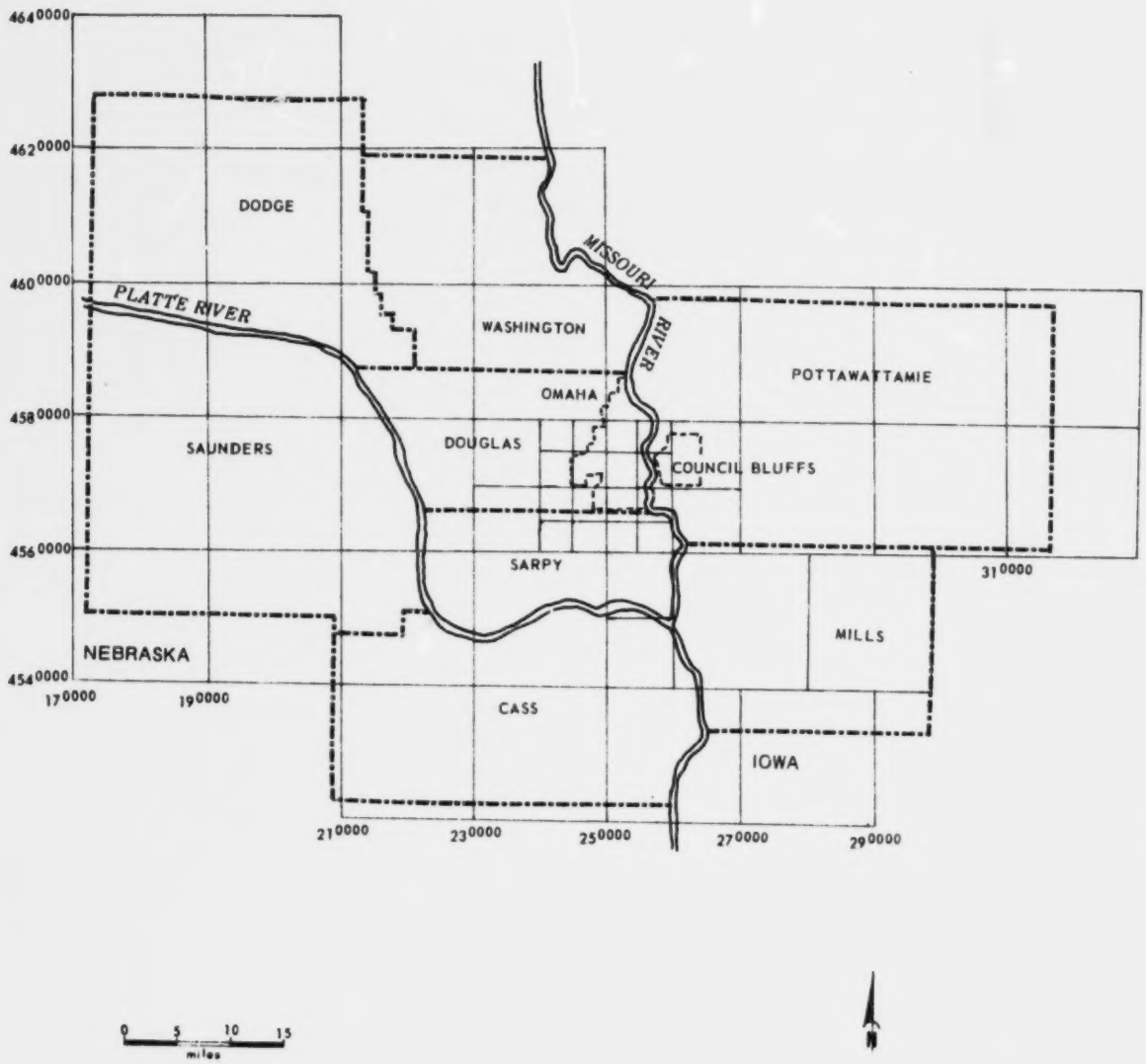

Figure 2. Omaha-Council Bluffs study area.

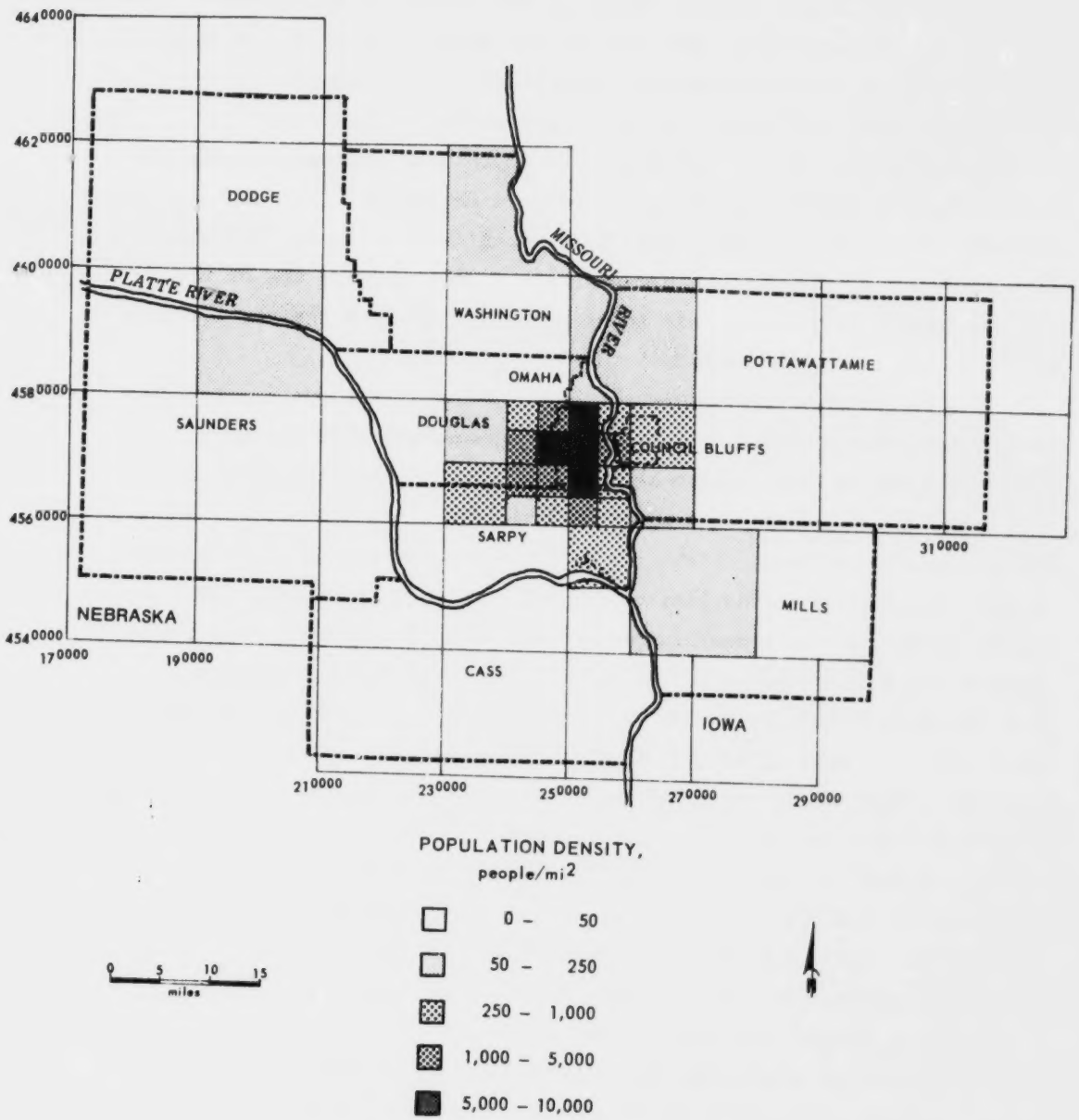

Figure 3. Population density for the Omaha-Council Bluffs study area, 1968.

GRID COORDINATE SYSTEM

A grid coordinate system, based on the Universal Transverse Mercator Projection (UTM), was used in the Omaha-Council Bluffs Study Area to indicate the geographical distribution of emissions. A map showing the grid coordinate system is presented in Figure 4.

An evaluation of all the available coordinate systems was completed before the UTM system was chosen to present emissions. The most convenient systems evaluated were the State Plane, Longitude-Latitude, and UTM. Although each of the systems had valuable qualities, the use of the UTM coordinate system was felt to be necessary to meet the requirements of these emission inventories.

The two primary requisites of the grid coordinate system were used to evaluate each system. The first requirement was that the grid coordinate system had to have square grid zones, since the data were to be used in meteorological dispersion models. The grid zones, which the UTM system and most of the State Plane systems project, are always square, but the longitude-latitude system projects grid zones that become skewed as the zones become further from the equator. The other quality the grid coordinate system had to possess was consistency. Each emission inventory should be conducted on a grid coordinate system which uses the same reference point throughout the Study Area. Since some air pollutant inventories would include areas in two or more states, the State Plane systems could not be used. However, since the UTM system, as well as the longitude-latitude system, is not referenced to points in individual states, it is not influenced by jurisdiction boundaries. The UTM system was chosen since it was the only prevalent coordinate system which can project square grid zones over any Study Area using a common reference point.

The Universe Transverse Mercator Projection is based upon the metric system. Each north-south and east-west grid lines, as illustrated in Figure 4, is identified by a coordinate number expressed in meters.

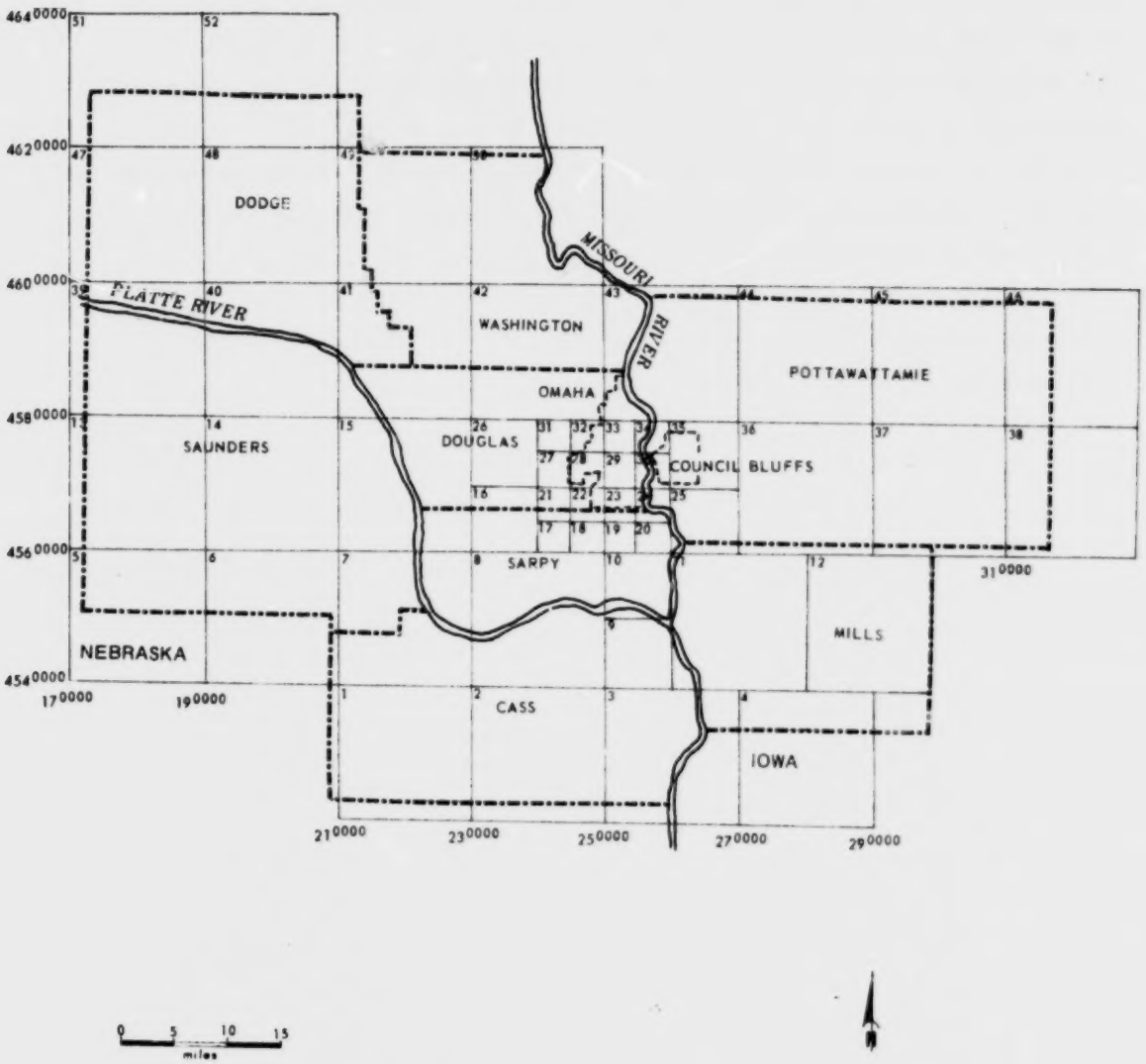

Figure 4. Omaha-Council Bluffs grid coordinate system.

Each point source and grid, using its geographical center, is identified by a horizontal and vertical coordinate to the nearest 100 meters.

Grid zones of different sizes are used in the grid coordinate system to allow a satisfactory definition of the geographical gradation of emissions and to limit the number of grid zones. The majority of the emissions is usually concentrated in the populated and industrialized portions of a Study Area. Smaller grids are placed over these areas to allow the grid coordinate system to reflect the changes of emissions over short distances. Grid zones smaller than the 25 kilometer grid zones used in this report are not usually warranted because of the inherent inaccuracies in the data. Larger grid zones are used in the rural portions, because a smaller percentage of the total emissions usually occurs in lightly populated areas.

EMISSIONS BY CATEGORY

TRANSPORTATION

Transportation is the source category concerned with mobile source of air pollutants. The sources in this category include: road vehicles (both gasoline and diesel powered), aircraft, vessels, and railroads. With the exception of aircraft, all the sources are presented as area sources. Since most of the aircraft emissions are attributable to the immediate vicinity of the airports, aircraft are presented as point sources.

Road Vehicles

METHODOLOGY: Vehicle miles of travel were obtained from a traffic study for parts of Douglas, Sarpy and Pottawattamie Counties. Total vehicle miles of travel for 1968 were obtained from Highway Statistics[3] using an average factor of fuel consumed per vehicle mile.

The vehicle miles of travel which included both gasoline and diesel vehicles was apportioned onto the grid system by traffic flow maps for the extent of the transportation study. For the balance of the Study Area emissions were apportioned by population.

Approximately 1.5 to 2.0 percent of gasoline is lost through evaporation from the gasoline tanks and carburetor losses. (This is exclusive of hydrocarbon losses from exhaust.) It was assumed that no diesel fuel was lost by evaporation. Since 1963 most new automobiles were equipped with positive crankcase ventilation (PVC) valves that reduce hydrocarbon emissions from the crankcase by about 90 percent. Due to a lag time in the automobile replacement rate, it was assumed that only 20 percent of the automobiles were not equipped with PCV valves.

RESULTS: More than 3.34 billion miles were traveled by motor vehicles in 1968. In the process, 258 million gallons of gasoline and 32 million gallons of diesel fuel were consumed for highway purposes.

TABLE 3 VEHICLE MILES OF TRAVEL AND FUEL CONSUMPTION IN THE STUDY AREA, 1968

County	Total Vehicle-Miles (10^3/Day)	Gasoline (10^6 Gallons/Year)	Diesel (10^6 Gallons/Year)
Cass	250	7.1	0.7
Dodge	760	21.4	2.9
Douglas	5,260	148.4	18.6
Sarpy	790	22.3	2.9
Saunders	315	8.9	1.1
Washington	145	4.2	0.3
Pottawattamie	1,410	39.7	5.0
Mills	220	6.2	0.7
TOTAL	9,150	258.2	32.2

Table 3 indicates that about 73 percent of all motor vehicle travel occurs in Douglas and Pottawattamie Counties.

The resulting emissions from motor vehicles are shown in Table 4. Motor vehicles are by far the most significant transportation source, accounting for 97 percent of the carbon monoxide and 77 percent of the hydrocarbons.

Aircraft

METHODOLOGY: The total number of flights by type was obtained from the Federal Aviation Administration. A flight is defined as the combination of a take-off and landing. Estimates were obtained from the control tower at each airport as to the kind and number of engines in each type category. Table 5 presents the results of these estimates at Eppley Field and Offut Air Force Base.

Emissions were obtained by applying the appropriate emission factors to the total number of flights in each engine and type category.

RESULTS: Table 6 presents the resulting air pollutant emissions from the two airports in the Study Area. As can be seen, the piston engines are the largest source of emissions among aircraft, accounting for 97 percent of the carbon monoxide and 96 percent of the hydrocarbons.

Trains

METHODOLOGY: The total fuel consumed by railroads in any State is given by the Bureau of Mines' Mineral Industry Surveys.[4] The proportion consumed in the Study Area was found by taking the ratio of population of the Study Area to that of the State (in both Iowa and Nebraska), times the total state fuel consumption. This fuel usage was apportioned to the individual grids by locating train routes and railroad yards.

RESULTS: The Summary of Air Pollutant Emission from Transportation Sources (Table 4) shows that trains are a significant source of particulates (37%), sulfur oxides (32%), and nitrogen oxides (18%) from this source category.

TABLE 4 AIR POLLUTANT EMISSIONS FROM TRANSPORTATION SOURCES FOR THE STUDY AREA, 1968 (TONS/YEAR)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Motor Vehicles	1,590	3,030	266,000	35,400	17,000
Gasoline					
Exhaust	950	1,270	265,000	19,900	13,500
Evaporation*	N	N	N	13,300	N
Diesel	640	1,760	1,000	2,200	3,500
Aircraft	N	240	6,500	1,260	440
Jet	N	200	140	50	120
Turboprop	N	10	30	10	20
Piston	N	30	6,330	1,200	300
Railroads	710	1,940	1,060	2,400	3,920
Vessels	30	70	40	90	140
TOTAL	2,330	5,280	273,600	25,850	21,500

* Included in the evaporative losses total

N = Negligible

TABLE 5 AIRCRAFT FLIGHTS FOR THE STUDY AREA, 1968

Airport and Engine Type	Number of Flights			
	1 Engine	2 Engine	3 Engine	4 Engine
Eppley Field				
Conventional Jet	0	11,500	6,500	0
Turboprop	0	7,700	6,500	0
Piston	60,600	27,600	0	0
OFFUT Air Force Base				
Conventional Jet	0	2,000	0	0
Turboprop	0	2,000	0	0
Piston	0	1,600	500	0

TABLE 6 AIR POLLUTANT EMISSIONS FROM AIRCRAFT, 1968
(TONS/YEAR)

Airport	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Eppley Field	N	220	6,150	1,190	400
OFFUT AFB	N	20	350	70	40
TOTAL	N	240	6,500	1,260	440

N = Negligible

Vessels

METHODOLOGY: The number of trips made by vessels on the Missouri River was obtained from the Army Corps of Engineers, Missouri River Division. An average quantity of fuel per vessel trip was applied to the total and an average consumption of fuel while in port was used to determine the quantity of fuel consumed by this source category.

RESULTS: Air pollutant emissions from vessels are shown in Table 4. It is apparent from this table that the percent contribution from this source category to total transportation emissions is negligible.

FUEL COMBUSTION IN STATIONARY SOURCES

All three of the major fuels (coal, oil, natural gas) are consumed within the Study Area, with natural gas being the most important. In 1968, natural gas accounted for 83 x 10^{12} BTU's of energy or about 82 percent of the total. As shown in Tables 7 and 8, 83 billion cubic feet of natural gas, 51 million gallons of distillate fuel oil, 6.4 million gallons of residual fuel oil and 383,000 tons of coal were consumed in the Study Area.

Natural gas is consumed to a large extent by all four consumer categories. Steam-electric utilities consume the largest amount with residential users consuming almost as much. Distillate fuel oil is consumed predominantly for residential home heating and commercial-institutional buildings. Residual fuel oil is used for one power plant and by some industrial consumers. Coal only finds usage in power plants.

There are four steam-electric power plants in the Study Area. Table 9 presents the fuels consumed as well as their sulfur and ash contents. The coal fired plants are equipped with cyclones and electrostatic precipitators. They use pulverized coal boilers.

METHODOLOGY: Natural gas consumption and fuels consumed by power plants were obtained from the utility companies and are considered accurate. However, the fuel oil figures were based on 1966 data updated to 1968 by state totals published by the Bureau of Mines, and thus are approximations.[4,5]

The emissions from fuel combustion in area sources were apportioned to the individual grids by population.

RESULTS: The resulting emissions are presented in Table 10. The combustion of coal, although providing 9.8 percent of the energy input, produces the majority of emissions from combustion of stationary fuels. Only in the case of nitrogen oxides does natural gas (82 percent of energy) account for any significant emission rate.

Fuel combustion in stationary sources is a significant source of sulfur oxides (64 percent) and nitrogen oxides (39 percent) to the total area's pollution.

TABLE 7 NATURAL GAS CONSUMPTION BY CONSUMER CATEGORY, 1968
(10^6 Ft.^{3})

County	Steam-Electric	Industry	Commercial-Institutional	Residential
Cass	0	2,690	80	600
Dodge	0	6,180	800	1,810
Douglas	21,850	10,800	5,570	15,340
Sarpy	0	330	1,200	1,060
Saunders	0	140	90	350
Washington	0	250	150	350
Pottawattamie	6,610	1,240	1,150	3,490
Mills	0	130	120	280
TOTAL	28,460	21,760	9,160	23,280

TABLE 8 COAL AND FUEL OIL CONSUMPTION FOR THE STUDY AREA, 1968

County	Distillate Oil (10^3 Gallons)		Residual Oil (10^3 Gallons)		Coal (10^3 Tons)
	Residential	C & I	Industry	Steam-Electric	Steam-Electric
Cass	2,220	N	N	0	0
Dodge	2,550	N	N	0	0
Douglas	27,150	2,500	3,800	2,270	381
Sarpy	4,530	N	N	0	0
Saunders	3,400	N	N	0	0
Washington	1,890	N	N	0	0
Pottawattamie	4,210	300	300	0	102
Mills	2,190	N	0	0	0
TOTAL	48,140	2,800	4,100	2,270	483

C & I = Commercial and Institutional

N = Negligible

TABLE 9 FUEL CONSUMPTION IN STEAM-ELECTRIC POWER PLANTS, 1968

Plant	Coal 10^3 Tons	Residual Fuel Oil 10^3 Gallons	Natural Gas 10^6 Ft.^{3}
North Omaha	371	0	19,100
South Omaha	0	2,270	2,180
Jones Street	10	0	570
Council Bluffs	102	0	6,610
TOTAL	383	2,270	28,460

SULFUR AND ASH CONTENTS OF FUELS CONSUMED IN STEAM-ELECTRIC POWER PLANTS

Plant	Coal % Ash	Coal % Sulfur	Residual Oil % Sulfur
North Omaha	10.0	3.8	--
South Omaha	--	--	2.0
Jones Street	10.0	3.8	--
Council Bluffs	9.3	3.7	--

TABLE 10 AIR POLLUTANT EMISSIONS FROM STATIONARY FUEL COMBUSTION, 1968 (TONS/YEAR)

Fuel	User Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Coal	Steam-Electric	34,700	1,120	120	50	4,830
Residual Fuel Oil	Steam-Electric	400	10	N	N	120
	Industrial	700	70	10	10	270
	Total	1,100	80	10	10	390
Distillate Fuel Oil	Residential	760	190	50	70	290
	Commercial-Institutional	N	N	N	N	N
	Total	760	190	50	70	290
Natural Gas	Residential	10	220	N	N	1,350
	Commercial-Institutional	N	90	N	N	530
	Industrial	N	200	N	N	2,330
	Steam-Electric	N	220	N	N	5,550
	Total	10	730	N	N	9,760
TOTAL		36,570	2,120	180	130	15,270

N = Negligible

SOLID WASTE

METHODOLOGY: The total solid waste generated within the Study Area was found by applying the national average per capita generation rate of 10 pounds of refuse per day to the total Study Area resident population.[6] This generation rate includes both collected and uncollected waste. On the average 5.5 lb/day of waste is collect by municipalities for disposal. This figure includes household, commercial and industrial refuse. The remaining 4.5 lb/day includes industrial (3.0 lb/day), and commercial and other household (1.5 lb/day).

The disposal methods for Douglas, Sarpy and Pottawattamie Counties were determined from an extensive study by the Omaha-Council Bluffs Metropolitan Area Planning Agency.[7] For the remaining counties, national averages of disposal method quantities were applied to the known disposal methods of the jurisdiction involved.

The emissions from large municipal and private disposal facilities were calculated individually and located within the Study Area. The remaining waste (on-site incineration, on-site open burning, and small open burning dumps) were treated as area sources and were apportioned onto the grid system by population.

RESULTS: Table 11 which is a solid waste balance for the Study Area shows the results of the above methodology. The predominant disposal practices within the Study Area are sanitary landfills (35%) and on-site open burning (25%). There are no municipal incinerators. The majority of emissions in this category (Table 12) comes from open burning.

TABLE 11 SOLID WASTE DISPOSAL PRACTICES FOR THE STUDY AREA

1968 (Tons/Year)

County	Waste Generated	Open Burning		Incineration	Sanitary Landfills	Hauled in - or out +
		Dumps	On-Site	On-Site		
Cass	17,000	--	17,000	0	0	
Dodge	37,000	--	37,000	0	0	
Douglas	720,000	100,000	110,000	140,000	150,000	+ 220,000
Sarpy	86,000	17,000	27,000	17,000	25,000	
Saunders	16,000	--	16,000	0	0	
Washington	13,000	--	13,000	0	0	
Pottawattamie	160,000	130,000	30,000	30,000	190,000	- 220,000
Mills	13,000	--	13,000	0	0	
TOTAL	1,062,000	247,000	263,000	187,000	365,000	0

TABLE 12 AIR POLLUTANT EMISSIONS FROM SOLID WASTE DISPOSAL PRACTICES IN THE STUDY AREA, 1968 (TONS/YEAR)

Source	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Incineration					
Municipal	0	0	0	0	0
On-Site	190	930	4,110	70	280
Total	190	930	4,110	70	280
Open Burning					
On-Site	90	1,310	6,970	2,460	900
Dumps	120	2,290	10,630	3,690	1,340
Total	210	3,600	17,600	6,150	2,240
GRAND TOTAL	400	4,530	21,710	6,220	2,520

INDUSTRIAL PROCESSES

The major industries in the Study Area are in food (which includes meat packing, grain handling, etc.) and printing. These two major industrial classifications account for about 50% of industrial establishments as shown in Table 13.

In addition, there are large commercial and governmental employers in the Area (insurance companies and Strategic Air Command Headquarters). Thus, most of the working population is employed in non-process industries.

The Study Area does contain, one cement plant, an ammonia plant, two lead smelters, one large iron foundry and brass and bronze foundry, one fertilizer plant and a multitude of concrete batching plants, asphalt batching plants, grain elevators, grain mills and dehydrating plants.

METHODOLOGY: Data for large industrial processers were collected in cooperation with local and state air pollution agencies. Typical data collected included: fuel consumption, amount of product, type of process, air pollution control equipment, and collection or operating efficiencies. This data was then used along with appropriate emission factors to estimate pollutant emissions.

RESULTS: Table 14 gives process emission totals from industrial categories. The major emitters of particulate matter are the grain (54%) and cement (35%) industries. Metal foundries and asphalt and concrete batching account for most of the remainder.

Emissions from this category are by no means complete totals. A lack of time did not allow for a complete survey of all the industry in the area. In addition, a lack of published emission factors did not allow estimates to be made for all industry groups.

TABLE 13 DISTRIBUTION OF ESTABLISHMENTS BY SELECTED MAJOR INDUSTRY GROUPS FOR THE OMAHA-COUNCIL BLUFFS STUDY AREA, 1963

County	MAJOR SIC CLASSIFICATION 20	27	32	34	35	Total
Cass	--	3	4	--	--	9
Dodge	23	10	4	3	5	59
Douglas	113	99	30	45	57	525
Sarpy	1	2	1	1	--	11
Saunders	7	5	1	--	3	17
Washington	7	3	1	--	5	17
Pottawattamie	18	12	2	4	3	62
Mills	5	2	--	--	1	8
TOTAL						

20 = Food and Kindred

27 = Printing and Publishing

32 = Stone, Clay and Glass

34 = Fabricated Metals

35 = Machinery, except electrical

Note: Includes only those establishments over 20 employees.

TABLE 14 SUMMARY OF EMISSIONS FROM PROCESS LOSSES, 1968

(Tons/Year)

Source	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Concrete Batching	--	270	--	--	--
Cement	--	6,640	--	--	--
Metal Foundries	15,000	1,240	2,500	--	--
Asphalt Batching	0	550	--	--	--
Grain Handling	0	10,400	--	--	--
Other	3,000	--	--	--	--
TOTAL	18,000	19,100	2,500	0	0

EVAPORATIVE LOSSES

The sources of solvent evaporation considered in this survey were industry, dry cleaning and motor vehicles.

METHODOLOGY: Industrial solvent evaporation was found from individual source information. Dry cleaning emissions were calculated using a per capita rate of 5.0 lb/year.[8] This was apportioned to the grid system by population. Motor vehicle emissions were determined from the vehicle miles, age of vehicle and extent of control equipment (see transportation-motor vehicles). This was broken down on a grid basis in a manner similar to that used for exhaust emissions from motor vehicles.

RESULTS: There was over 21,500 tons of hydrocarbons emitted, of which 7,000 was industrial; 1,250 was from dry cleaning operations and 13,300 were from automobiles.

EMISSIONS BY JURISDICTION

The previous section of this report presents emissions primarily by source category. The emissions by county and source are summarized here in Tables 15 through 22.

As is expected due to a higher degree of urbanization than the other counties, Douglas and Pottawattamie contribute to the majority of air pollutants.

TABLE 15 SUMMARY OF AIR POLLUTANT EMISSIONS IN CASS COUNTY 1968, (TONS/YEAR)

Source	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	40	80	7,270	610	470
Other	N	N	N	N	N
Sub-Total	40	80	7,270	610	470
Stationary Fuel Combustion					
Industry	N	30	N	N	290
Steam-Electric	0	0	0	0	0
Residential	40	10	N	N	50
C & I	N	N	N	N	N
Sub-Total	40	40	0	0	340
Solid Waste					
Incineration	0	0	0	0	0
Open Burning	10	140	730	260	90
Sub-Total	10	140	730	260	90
Industrial Processes	N	6,640	N	N	N
Evaporative Losses				400	
TOTAL	90	6,900	8,000	1,260	900

N = Negligible

C & I = Commercial and Institutional

TABLE 16 SUMMARY OF AIR POLLUTANT EMISSIONS IN DODGE COUNTY
1968 (TONS/YEAR)

Source	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	130	250	22,200	1,840	1,420
Other	N	N	N	N	N
Sub-Total	130	250	22,200	1,840	1,420
Stationary Fuel Combustion					
Industry	N	60	N	N	660
Steam-Electric	0	0	0	0	0
Residential	40	30			120
C & I	N	10	N	N	50
Sub-Total	40	100	0	0	830
Solid Waste					
Incineration	0	0	0	0	0
Open Burning	20	290	1,160	560	200
Sub-Total	20	290	1,160	560	200
Industrial Processes					
Evaporative Losses				1,180	
TOTAL	190	640	23,800	3,580	2,450

N = Negligible

C & I = Commercial and Institutional

TABLE 17 SUMMARY OF AIR POLLUTANT EMISSIONS IN DOUGLAS COUNTY
1968 (TONS/YEAR)

County	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	910	1,740	152,580	12,700	9,780
Other	560	1,740	6,980	3,080	3,490
Sub-Total	1,470	3,480	159,560	15,780	12,270
Stationary Fuel Combustion					
Industry	650	160	10	10	1,390
Steam-Electric	27,970	1,100	100	40	8,190
Residential	430	250	30	40	1,050
C & I	N	50	N	N	320
Sub-Total	29,050	1,560	140	90	10,950
Solid Waste					
Incineration	140	700	3,080	60	210
Open Burning	50	1,170	4,720	1,590	570
Sub-Total	190	1,870	7,800	1,650	780
Industrial Processes	18,000	12,370	2,500	N	N
Evaporative Losses				15,380	
TOTAL	48,700	19,280	170,000	32,900	25,100

N = Negligible

C & I = Commercial and Institutional

TABLE 18 SUMMARY OF AIR POLLUTANT EMISSIONS IN SARPY COUNTY
1968 (TONS/YEAR)

Source	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	140	260	23,000	1,910	1,470
Other	90	260	470	360	510
Sub-Total	230	520	23,470	2,270	1,980
Stationary Fuel Combustion					
Industry	N	10	N	N	60
Steam-Electric	0	0	0	0	0
Residential	70	30	N	10	80
C & I	N	10	N	N	70
Sub-Total	70	50	0	10	210
Solid Waste					
Incineration	10	90	380	10	30
Open Burning	20	340	1,850	650	240
Sub-Total	30	430	2,230	660	270
Industrial Processes	N	50	N	N	N
Evaporative Losses				1,240	
TOTAL	330	1,050	25,700	4,180	2,460

N = Negligible

C & I = Commercial and Institutional

TABLE 19 SUMMARY OF AIR POLLUTANT EMISSIONS IN SAUNDERS COUNTY
1968 (TONS/YEAR)

Source	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	50	100	9,170	760	590
Other	N	N	N	N	N
Sub-Total	50	100	9,170	760	590
Stationary Fuel Combustion					
Industry	N	N	N	N	10
Steam-Electric	0	0	0	0	0
Residential	50	20	N	10	40
C & I	N	N	N	N	10
Sub-Total	50	20	0	10	60
Solid Waste					
Incineration	0	0	0	0	0
Open Burning	10	130	680	240	90
Sub-Total	10	130	680	240	90
Industrial Processes	N	N	N	N	N
Evaporative Losses				490	
TOTAL	110	250	9,850	1,500	730

N = Negligible

C & I = Commercial and Institutional

TABLE 20 SUMMARY OF AIR POLLUTANT EMISSIONS IN WASHINGTON COUNTY, 1968 (TONS/YEAR)

Source	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	30	50	4,240	350	270
Other	N	N	N	N	N
Sub-Total	30	50	4,240	350	270
Stationary Fuel Combuation					
Industry	N	N	N	N	30
Steam-Electric	0	0	0	0	0
Residential	30	10	N	N	30
C & I	N	N	N	N	10
Sub-Total	30	10	0	0	70
Solid Waste					
Incineration	0	0	0	0	0
Open Burning	N	110	560	190	70
Sub-Total	0	110	560	190	70
Industrial Processes	N	N	N	N	N
Evaporative Losses				240	
TOTAL	60	170	4,800	780	410

N = Negligible

C & I = Commercial and Institutional

TABLE 21 SUMMARY OF AIR POLLUTANT EMISSIONS IN POTTAWATTAMIE COUNTY, 1968 (TONS/YEAR)

Source	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Motor Vehicles	250	470	41,090	3,410	2,620
Other	90	250	140	310	510
Sub-Total	340	720	41,230	3,720	3,130
Stationary Fuel Combustion					
Industry	50	20	N	N	150
Steam-Electric	7,180	240	20	10	2,310
Residential	70	50	10	10	230
C & I	N	10	N	N	70
Sub-Total	7,300	320	30	20	2,760
Solid Waste					
Incineration	30	150	660	10	40
Open Burning	80	1,310	6,980	2,450	900
Sub-Total	110	1,460	7,640	2,460	950
Industrial Processes	N	50	N	N	N
Evaporative Losses				2,230	
TOTAL	7,750	2,550	48,900	8,430	6,840

N = Negligible

C & I = Commercial and Institutional

TABLE 22 SUMMARY OF AIR POLLUTANT EMISSIONS IN MILLS COUNTY
1968 (TONS/YEAR)

Sources	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	40	70	6,400	530	410
Other	N	N	N	N	N
Sub-Total	40	70	6,400	530	410
Stationary Fuel Combustion					
Industry	N	N	N	N	10
Steam-Electric	0	0	0	0	0
Residential	30	10	N	N	30
C & I	N	N	N	N	10
Sub-Total	30	10	0	0	50
Solid Waste					
Incineration	0	0	0	0	0
Open Burning	10	110	550	200	70
Sub-Total	10	110	550	200	70
Industrial Processes	N	N	N	N	N
Evaporative Losses				340	
TOTAL	70	190	6,950	1,070	530

N = Negligible

C & I = Commercial and Institutional

TABLE 23 RELATIVE CONTRIBUTION OF EACH COUNTY TO TOTAL AIR POLLUTANT EMISSIONS, (Percent)

County	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Cass	N	22	3	2	2
Dodge	/1	2	8	7	6
Douglas	85	62	57	61	64
Sarpy	/1	3	9	8	6
Saunders	N	1	3	3	2
Washington	N	1	1	1	1
Pottawattamie	14	8	17	16	17
Mills	N	1	2	2	2

N = Negligible

EMISSIONS BY GRID

For the purpose of defining the geographical variation of air pollutant emissions in the Study Area, the resulting emissions were apportioned on the grid coordinate system. The emissions were divided into two source groups--point and area sources. Twenty-eight point sources are identified individually with respect to location and emissions. Each of these point sources emit more than 0.5 ton per day of any pollutant.

Figure 5 shows the location of most of the point sources in the area. Collectively the 28 point sources account for 93 percent of the sulfur oxides, 75 percent of particulates, 7 percent of carbon monoxide, 23 percent of hydrocarbons and 31 percent of nitrogen oxides. The percent contribution to carbon monoxide emissions is low because motor vehicles, which are area sources account for 90 percent of the total carbon monoxide emissions. Similarly, the contribution to total hydrocarbon emissions is low since two groups of area sources, motor vehicles and evaporative losses are major contributors. Table 24 presents the emissions of point sources. It has been assumed that seasonal variations in point sources are negligible.

Area sources are sources of emissions that are insignificant by themselves, but as a group emit a significant amount. Examples are motor vehicles, residential houses, light commercial and industrial establishments and backyard burning. The emissions from area sources have been added to that for point sources to obtain total emissions by grid as given in Table 25.

The emissions are presented for an annual average day, and average winter (December, January, February) day, and an average summer (June, July, August) day. The annual average daily emission rates were obtained by dividing yearly totals by 365. Seasonal averages were calculated by

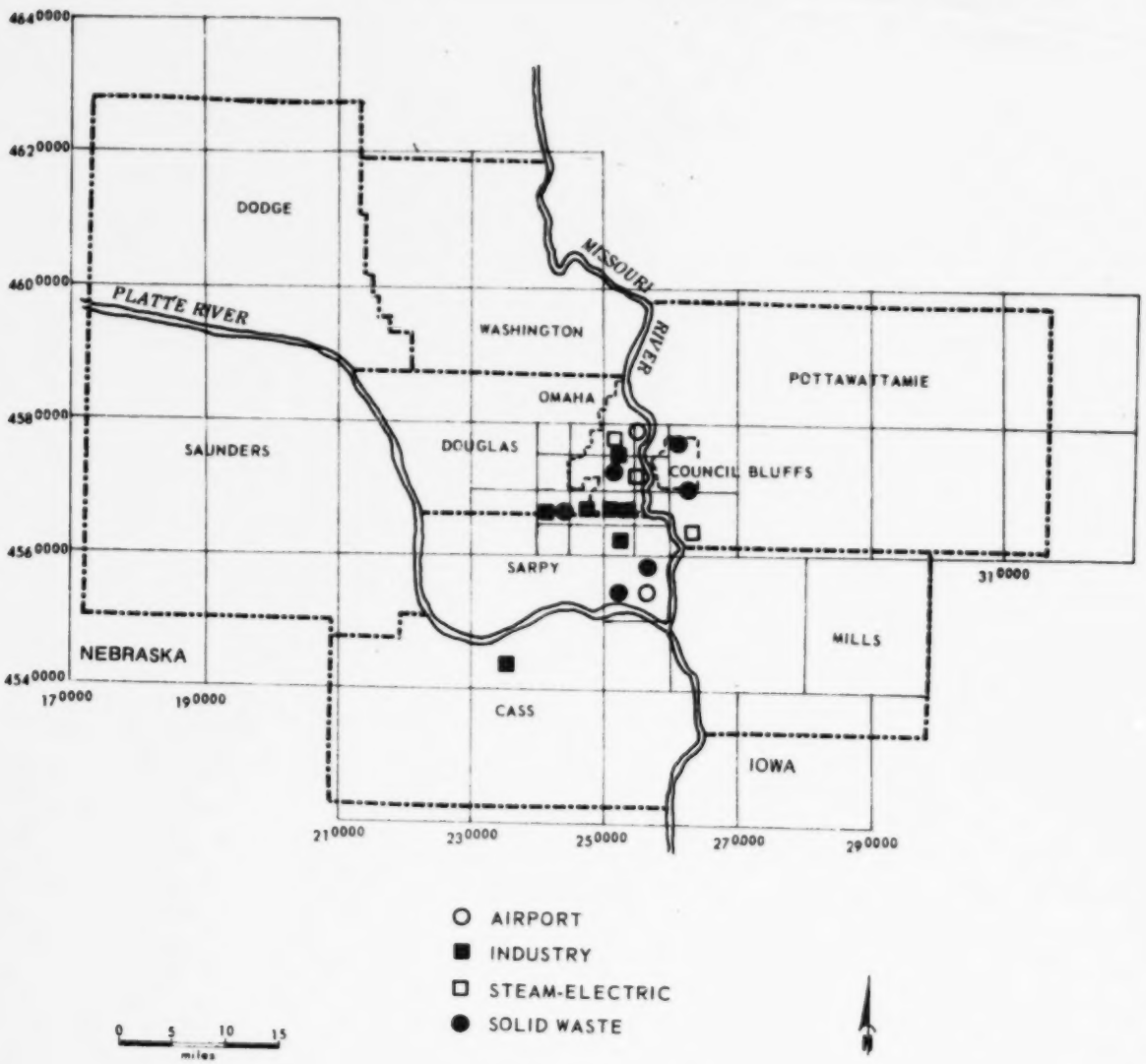

Figure 5. Location of point sources in the Omaha-Council Bluffs study area, 1968.

the use of space heating variations in fuel consumption and variations in motor vehicle traffic activity. This method is described in detail in the appendix. Other sources were assumed to be constant throughout the year.

EMISSION DENSITIES

In order to provide a visual representation of the emissions of pollutants by grid, emission density maps have been provided. Figures 6 through 10 show variation in emission densities for the respective grids throughout the Study Area. As expected the emissions generally follow the pattern and degree of urbanization. Emission densities are higher in grids with high populations and correspondingly high vehicular and industrial activity.

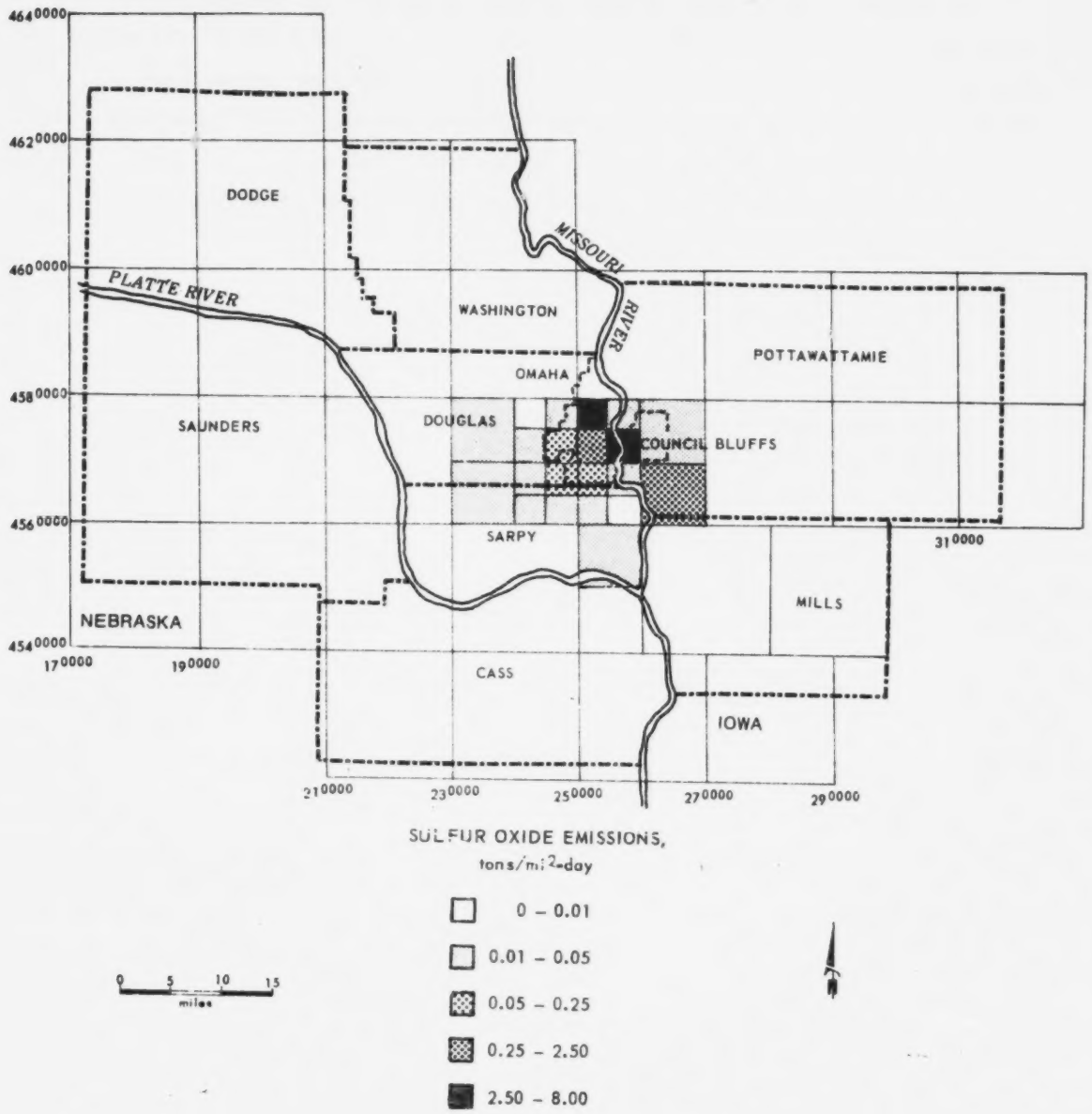

Figure 6. Sulfur oxide emission density for the Omaha-Council Bluffs study area, 1968.

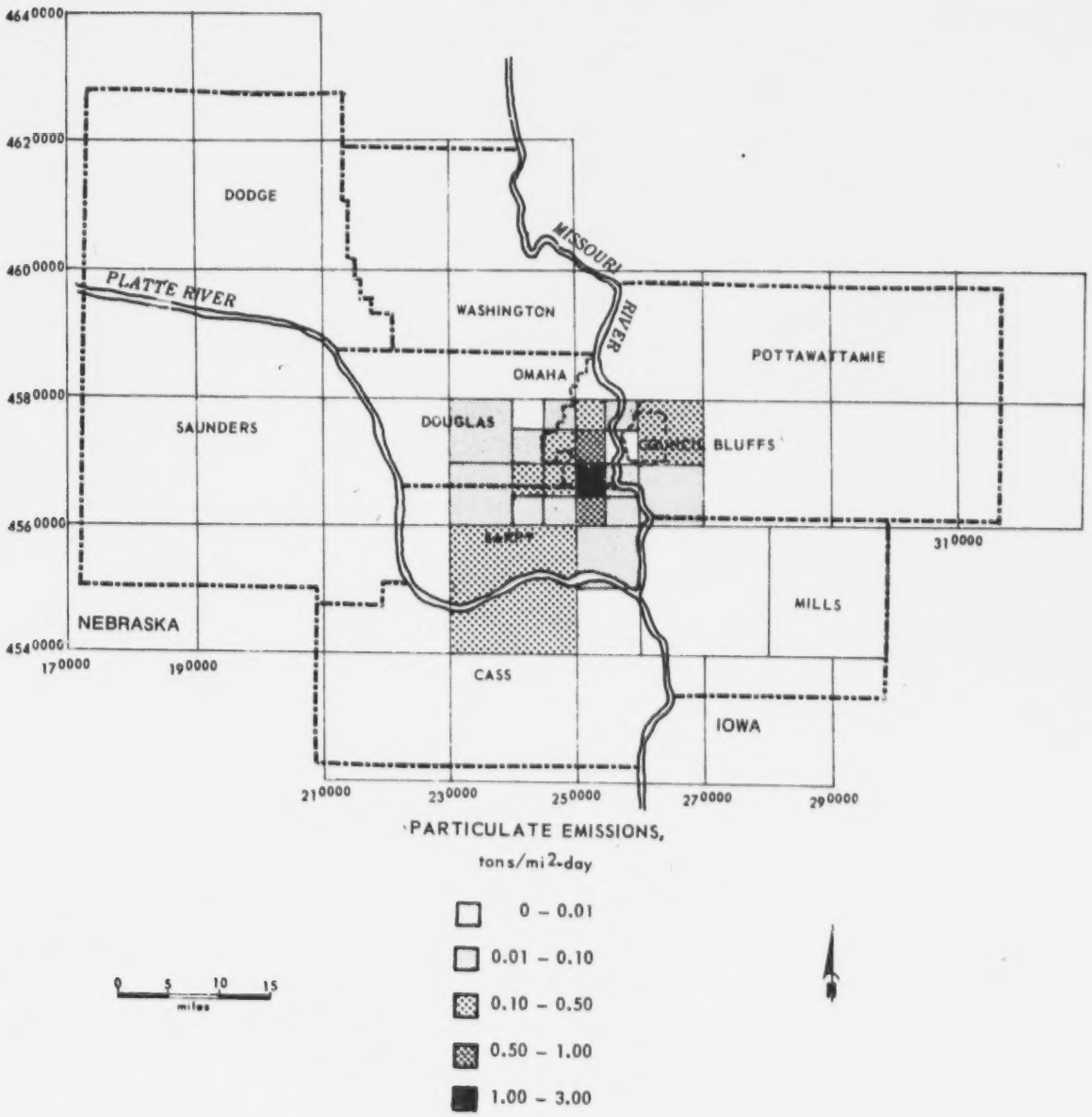

Figure 7. Particulate emission density for the Omaha-Council Bluffs study area, 1968.

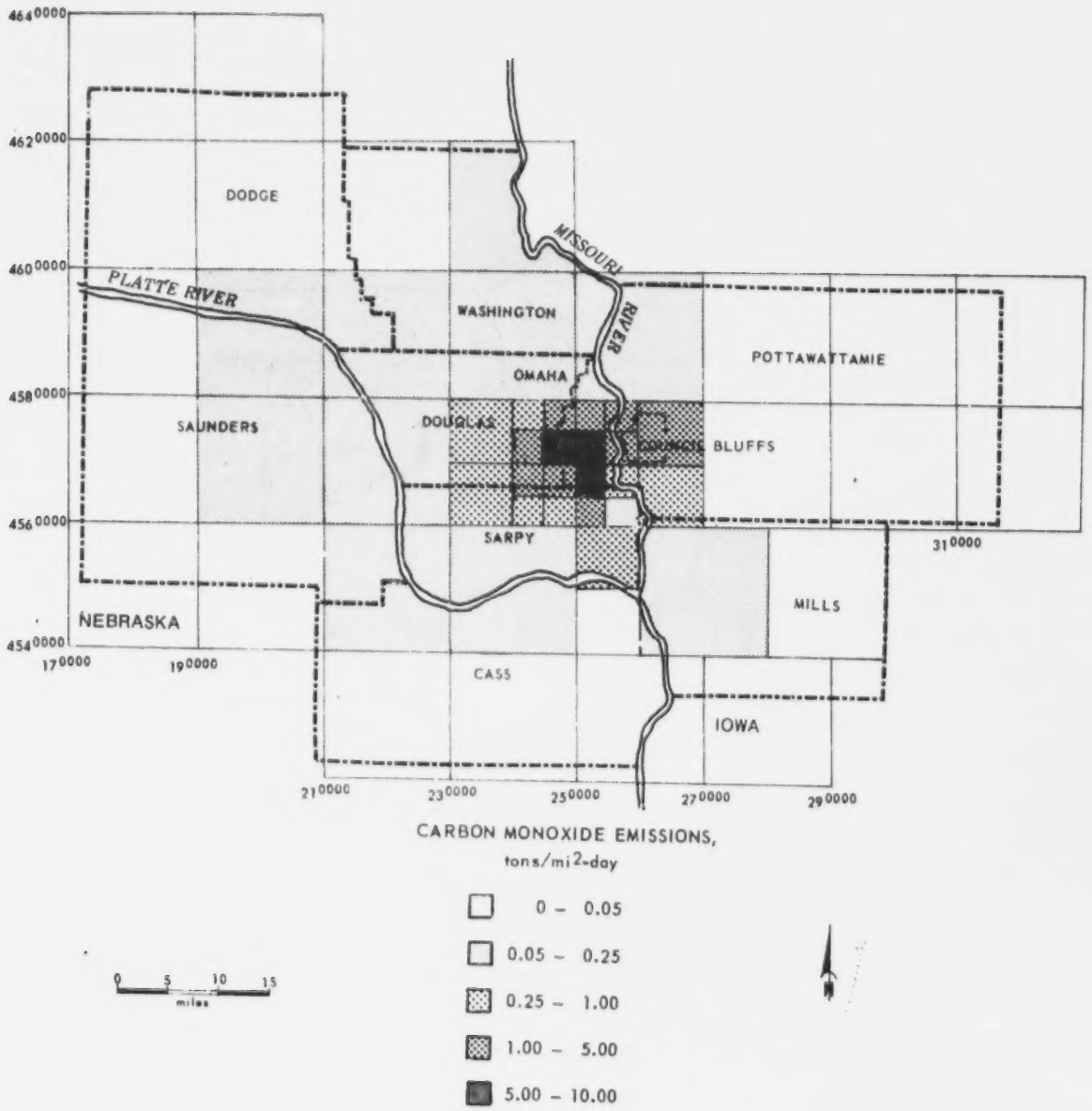

Figure 8. Carbon monoxide emission density for the Omaha-Council Bluffs study area, 1968.

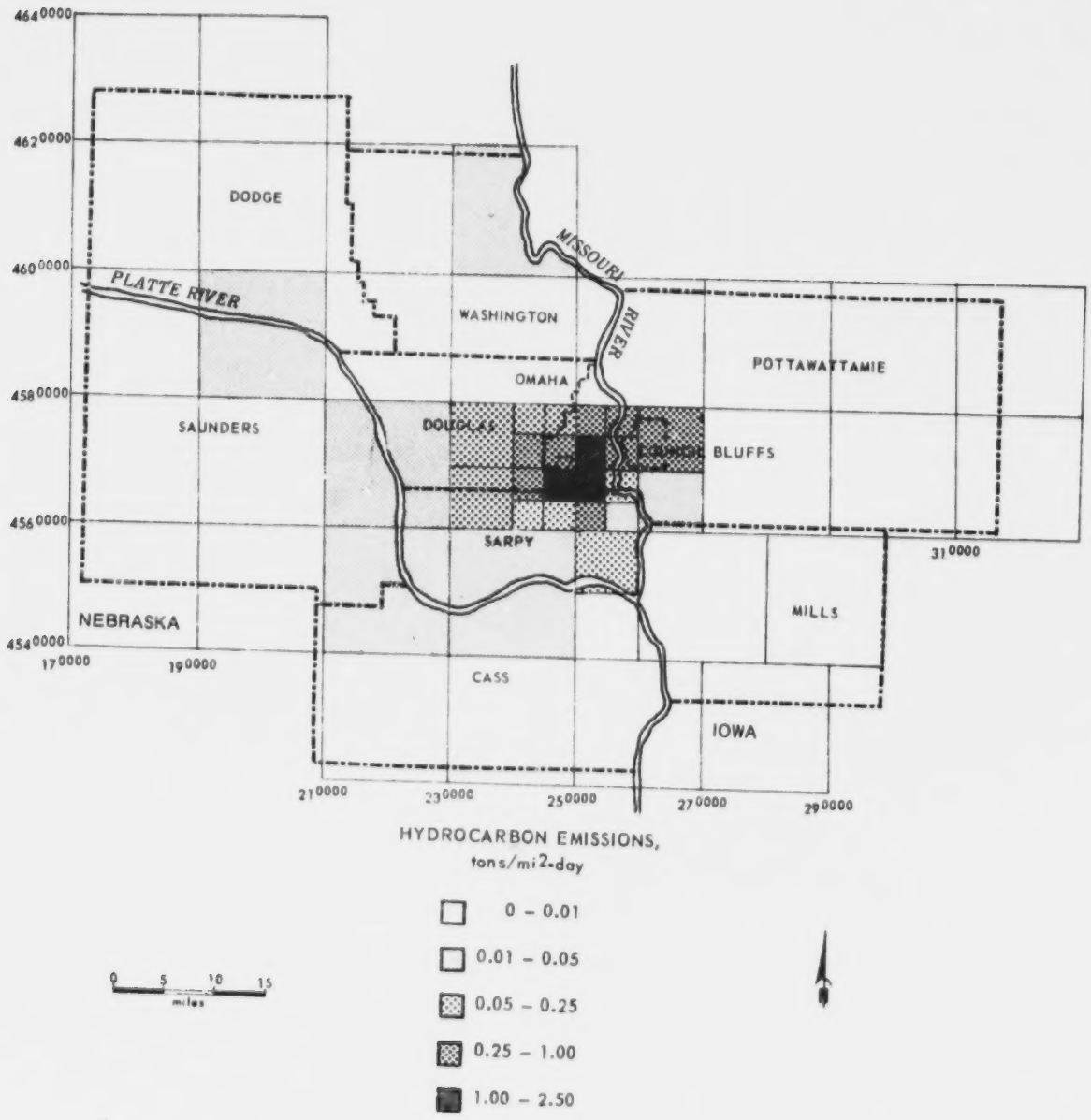

Figure 9. Hydrocarbon emission density for the Omaha-Council Bluffs study area, 1968.

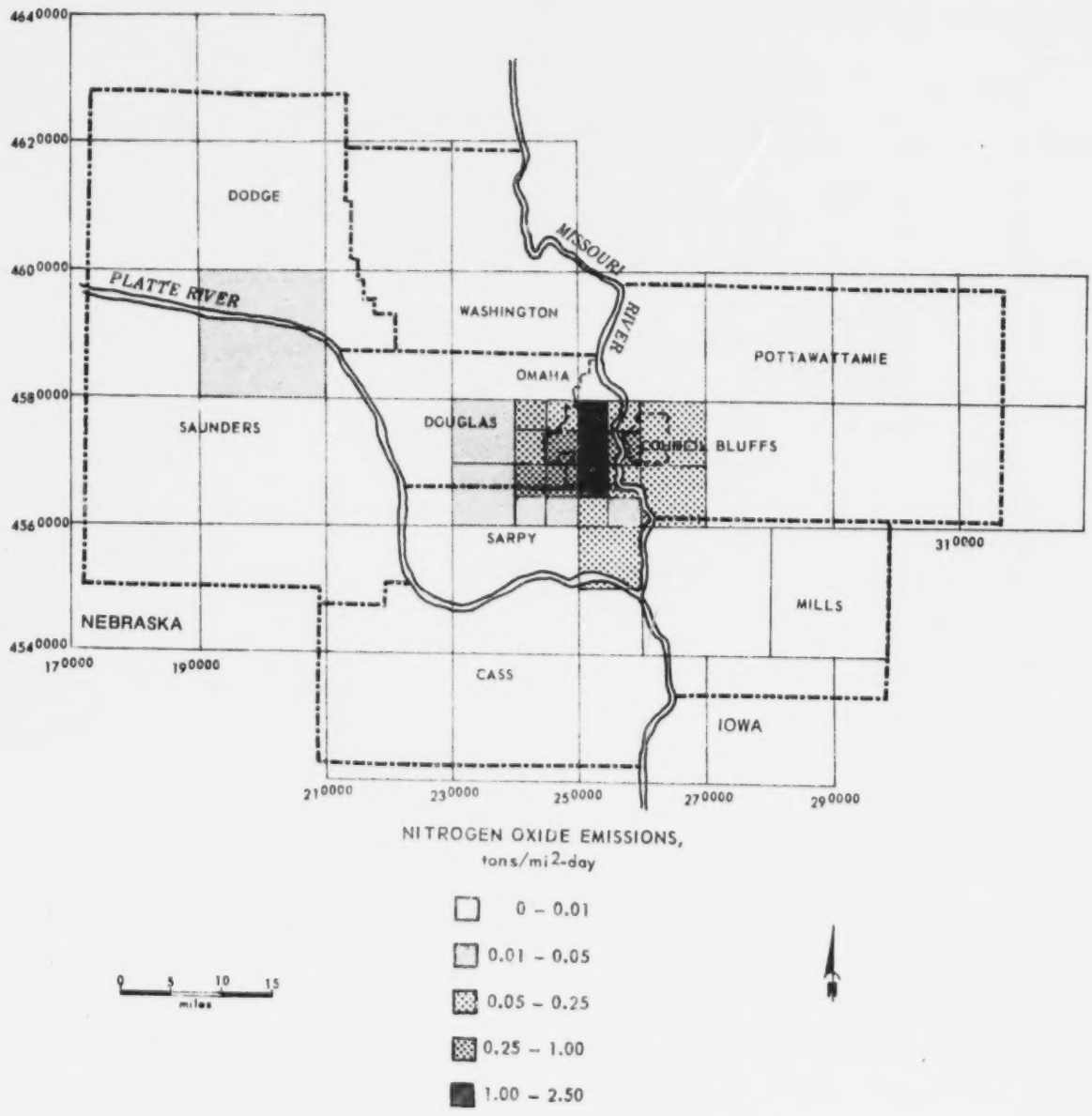

Figure 10. Nitrogen oxide emission density for the Omaha-Council Bluffs study area, 1968.

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8. Duprey, op. cit.

APPENDIX

METHOD FOR CALCULATING SUMMER, WINTER AND ANNUAL AVERAGE EMISSIONS FOR FUEL CONSUMPTION IN STATIONARY SOURCES

YEARLY AVERAGE (A)

$$A = \frac{\text{Fuel Consumed} \times \text{Emission Factor (E. F.)}}{\text{Days of Operation}}$$

e.g. A plant consumed 100,000 tons of coal in 1967 while operating 365 days. The total degree days for the area was 4,800 and 2,800 for the three winter months. The plant was estimated to use 15 percent of the fuel for space heating and 85 percent for process heating. From this information, the annual average emission for carbon monoxide would be the following:

$$A = \frac{100{,}000 \text{ Tons/year} \times 3 \text{ lbs. CO/Ton coal}}{365 \text{ Days/year} \times 2{,}000 \text{ lb./Ton}}$$

$$A = 0.41 \text{ Ton/Day}$$

WINTER AVERAGE (W)

$$W = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Winter Operation}} \times \frac{\text{Winter Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$W = \left[\frac{100{,}000 \times 2{,}800}{90 \times 4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$W = 0.49 \text{ Ton/Day}$$

SUMMER AVERAGE (S)

$$S = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Summer Operation}} \times \frac{\text{Summer Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$S = \left[\frac{100{,}000}{90} \times \frac{0}{4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$S = 0.35 \text{ Ton/Day}$$

TABLE 24 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES

Source	Grid	HC	VC	SOx	PART.	CO	HC	NOx
Industrial	8	2360	45420	0.0	18.19	0.00	0.00	0.00
Institutional	10	2540	45770	0.0	0.14	0.00	0.00	0.00
Solid Waste	10	2561	45592	0.0	0.21	1.16	0.41	0.15
Solid Waste	10	2515	45551	0.0	0.10	0.53	0.18	0.06
Airport	10	2553	45560	0.0	0.05	0.94	0.18	0.07
Industrial	19	2517	45645	0.0	5.69	0.00	0.00	0.00
Industrial	21	2407	45674	0.0	0.00	0.00	1.50	0.00
Solid Waste	21	2410	45675	0.0	0.95	1.19	0.28	0.07
Industrial	22	2466	45670	0.0	0.00	0.00	10.29	0.03
Steam Electric Utility	23	2521	45655	1.0	0.07	0.00	0.01	1.50
Industrial	23	2545	45669	0.0	0.04	0.00	4.10	0.00
Industrial	23	2510	45665	0.0	0.52	0.00	0.00	0.07
Industrial	23	2523	45690	0.0	0.58	6.86	0.00	0.00
Industrial	23	2500	45650	0.0	0.61	0.00	0.00	0.00
Industrial	23	2532	45695	0.0	5.69	0.00	0.00	0.00
Industrial	23	2528	45670	0.0	5.69	0.00	0.00	0.00
Industrial	23	2525	45682	0.0	5.69	0.00	0.00	0.00
Industrial	23	2523	45657	0.0	4.69	0.00	0.00	0.00
Steam Electric Utility	25	2635	45634	19.9	0.66	0.07	0.02	6.42
Industrial	29	2549	45700	8.2	0.00	0.00	3.15	0.00
Solid Waste	29	2540	45665	0.1	1.88	10.01	3.53	1.29

TABLE 24 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES (cont.)

Source	Grid	HC	VC	SOx	PART.	CO	HC	NOx
Steam Electric Utility	30	2551	45705	2.0	0.12	0.00	0.00	0.58
Industrial	30	2550	45713	4.0	0.50	0.00	0.00	0.02
Industrial	30	2550	45715	36.9	1.80	0.00	0.00	0.00
Steam Electric Utility	33	2527	45790	74.4	2.87	0.25	0.10	20.65
Airport	34	2575	45755	0.0	0.60	16.85	3.26	1.11
Solid Waste	35	2505	45690	0.0	1.02	5.42	1.91	0.70
Solid Waste	35	2510	45730	0.1	1.86	9.89	3.49	1.28

TABLE 25 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES (cont.)

Grid	Land Area (Sq. Mi.)	SOx			PART.			CO			HC			NOx		
		S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
22	9.6	0.5	0.7	0.5	1.1	1.1	1.1	46.9	39.5	41.9	16.9	15.9	16.2	3.7	3.8	3.6
23	9.6	2.3	2.7	2.4	27.8	28.0	27.9	71.9	61.9	65.2	14.9	13.6	14.0	9.6	10.4	9.7
24	9.6	0.2	0.2	0.2	0.4	0.4	0.4	7.0	6.0	6.3	1.3	1.2	1.2	1.1	1.1	1.1
25	38.6	20.1	20.2	19.9	1.1	1.2	1.1	12.9	11.0	11.6	2.1	1.9	2.0	7.8	7.8	7.7
26	38.6	0.3	0.3	0.3	0.8	0.8	0.8	17.7	15.0	15.9	2.9	2.6	2.7	2.0	2.0	2.0
27	9.6	0.2	0.3	0.3	0.5	0.5	0.5	24.7	20.8	22.1	3.4	2.8	3.0	1.7	1.8	1.7
28	9.6	0.6	1.0	0.8	1.0	1.2	1.1	61.7	52.0	55.3	8.4	7.2	7.6	4.5	5.1	4.5
29	9.6	9.7	10.3	9.9	4.8	5.1	4.9	104.0	89.4	94.2	20.6	18.7	19.3	9.9	11.1	10.2
30	9.6	43.5	43.7	43.5	3.5	3.6	3.5	47.3	40.0	42.5	6.9	5.9	6.3	4.3	4.5	4.3
31	9.6	0.1	0.1	0.1	0.1	0.1	0.1	8.5	7.2	7.6	1.2	1.0	1.0	0.6	0.6	0.6
32	9.6	0.2	0.5	0.3	0.3	0.5	0.4	14.0	11.9	12.6	2.0	1.7	1.8	1.2	1.7	1.4
33	9.6	74.9	75.3	74.1	3.8	4.0	3.8	33.2	28.1	29.8	4.9	4.3	4.5	23.6	24.5	23.6
34	9.6	0.1	0.1	0.1	0.8	0.8	0.8	24.7	23.5	23.9	4.4	4.2	4.3	1.8	1.8	1.7
35	38.6	0.5	0.6	0.6	3.9	4.0	3.9	57.3	50.9	53.0	11.4	10.6	10.9	5.0	5.2	5.0
36	154.4	0.0	0.1	0.0	0.1	0.1	0.1	5.0	4.2	4.5	0.7	0.6	0.6	0.3	0.4	0.3
37	154.4	0.0	0.1	0.1	0.1	0.1	0.1	5.9	5.0	5.3	0.9	0.7	0.8	0.4	0.4	0.4
38	77.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.4	0.1	0.0	0.1	0.0	0.0	0.0
39	154.4	0.0	0.1	0.1	0.2	0.2	0.2	6.4	5.4	5.7	1.0	0.8	0.9	0.5	0.6	0.5
40	154.4	0.3	0.5	0.4	1.3	1.4	1.3	53.5	45.4	48.1	8.0	6.9	7.3	4.8	5.4	4.9
41	154.4	0.1	0.1	0.1	0.2	0.2	0.2	10.4	8.8	9.4	1.5	1.3	1.3	0.8	0.8	0.8
42	154.4	0.1	0.1	0.1	0.2	0.2	0.2	11.9	10.0	10.6	1.7	1.4	1.5	0.8	0.8	0.8

TABLE 25 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES

Grid	Land Area (Sq. Mi.)	SOx S	SOx W	SOx A	PART. S	PART. W	PART. A	CO S	CO W	CO A	HC S	HC W	HC A	NOx S	NOx W	NOx A
1	154.4	0.0	0.1	0.1	0.2	0.2	0.2	6.5	5.5	5.8	1.0	0.9	0.9	0.6	0.7	0.7
2	154.4	0.1	0.1	0.1	0.2	0.3	0.2	8.0	6.9	7.3	1.2	1.1	1.1	0.8	0.9	0.8
3	154.4	0.0	0.1	0.0	0.1	0.1	0.1	3.4	2.9	3.1	0.5	0.5	0.5	0.3	0.3	0.3
4	54.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.6	1.7	0.3	0.3	0.3	0.1	0.1	0.1
5	77.2	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.6	1.7	0.3	0.3	0.3	0.1	0.1	0.1
6	77.2	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.6	1.7	0.3	0.3	0.3	0.1	0.1	0.1
7	154.4	0.1	0.2	0.1	0.4	0.4	0.4	17.7	15.0	15.9	2.6	2.2	2.3	1.3	1.3	1.2
8	154.4	0.1	0.2	0.1	18.6	18.6	18.6	20.0	16.9	17.9	2.8	2.4	2.5	1.5	1.5	1.5
9	38.6	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.1	1.1	0.2	0.2	0.2	0.1	0.1	0.1
10	38.6	0.3	0.5	0.4	1.4	1.5	1.4	26.4	23.0	24.1	4.7	4.2	4.4	2.5	2.6	2.4
11	154.4	0.1	0.2	0.1	0.3	0.4	0.3	13.6	11.5	12.2	2.1	1.8	1.9	1.0	1.0	0.9
12	154.4	0.0	0.1	0.0	0.1	0.1	0.1	4.4	3.8	4.0	0.7	0.6	0.6	0.3	0.3	0.3
13	154.4	0.0	0.0	0.0	0.1	0.1	0.1	2.9	2.4	2.6	0.4	0.4	0.4	0.2	0.2	0.2
14	154.4	0.1	0.2	0.1	0.2	0.3	0.2	10.9	9.2	9.8	1.6	1.4	1.5	0.8	0.8	0.7
15	154.4	0.2	0.2	0.2	0.4	0.3	0.3	23.8	20.0	21.3	3.3	2.8	2.9	1.6	1.5	1.5
16	38.6	0.3	0.4	0.3	0.7	0.8	0.7	23.4	19.7	21.0	3.5	3.0	3.2	2.1	2.1	2.0
17	9.6	0.0	0.0	0.0	0.1	0.1	0.1	4.2	3.5	3.7	0.6	0.5	0.6	0.3	0.3	0.3
18	9.6	0.1	0.1	0.1	0.1	0.1	0.1	5.2	4.5	4.7	0.8	0.7	0.7	0.4	0.4	0.4
19	9.6	0.4	0.5	0.4	6.6	6.6	6.6	15.5	13.1	13.9	2.8	2.5	2.6	2.3	2.4	2.3
20	9.6	0.0	0.1	0.0	0.1	0.1	0.1	2.2	1.9	2.0	0.4	0.3	0.4	0.2	0.2	0.2
21	9.6	0.4	0.5	0.4	1.7	1.7	1.7	34.9	29.6	31.3	6.6	5.9	6.2	2.9	2.9	2.8

TABLE 25 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES (cont.)

Grid	Land Area (Sq. Mi.)	SOx			PART.			CO			HC			NOx		
		S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
43	154.4	0.1	0.1	0.1	0.2	0.2	0.2	10.1	8.5	9.0	1.4	1.2	1.3	0.7	0.8	0.7
44	154.4	0.1	0.1	0.1	0.1	0.1	0.1	6.7	5.6	6.0	0.9	0.8	0.9	0.5	0.5	0.5
45	154.4	0.0	0.0	0.0	0.1	0.1	0.1	4.6	3.9	4.2	0.7	0.6	0.6	0.3	0.3	0.3
46	77.2	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.7	0.8	0.1	0.1	0.1	0.1	0.1	0.1
47	154.4	0.0	0.0	0.0	0.1	0.1	0.1	3.1	2.7	2.8	0.5	0.4	0.4	0.3	0.3	0.3
48	154.4	0.0	0.0	0.0	0.1	0.1	0.1	5.2	4.4	4.7	0.8	0.7	0.7	0.5	0.5	0.5
49	154.4	0.0	0.1	0.0	0.1	0.1	0.1	3.7	3.2	3.4	0.6	0.5	0.5	0.3	0.3	0.3
50	77.2	0.1	0.1	0.1	0.2	0.3	0.2	7.8	6.7	7.0	1.3	1.1	1.2	0.6	0.7	0.6
51	54.0	0.0	0.0	0.0	0.1	0.1	0.1	3.5	3.0	3.1	0.5	0.5	0.5	0.3	0.4	0.3
52	54.0	0.0	0.0	0.0	0.1	0.1	0.1	2.1	1.8	1.9	0.3	0.3	0.3	0.2	0.2	0.2